Witness Statement
Testimony to the Committee on Resources of the

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Subcommittee on Energy and Mineral Resources

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Environmental Aspects of Modern Onshore Oil and Gas Development

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Madam Chairwoman and members of the Subcommittee:

Thank you for the asking me to appear before you today to participate in this important discussion. My name is John Amos, and I am President of SkyTruth, a nonprofit organization dedicated to applying satellite imagery for environmental analysis. I am trained as a geologist, with a bachelor's degree from Cornell University and a Master's degree obtained from the University of Wyoming. I have more than ten years of experience working as a consultant to oil and gas companies ranging from major multinationals to regional independents, using satellite images to evaluate the oil and gas potential of areas as diverse as Mongolia, offshore Venezuela, and the Green River Basin in Wyoming. Since 2001, I have applied my knowledge of satellite image acquisition, processing and analysis to help inform the public about the effects of drilling for natural gas on federally managed lands throughout the Rocky Mountain west. I am here today in that capacity.

One of the main environmental concerns related to onshore oil and gas development is the direct and indirect impact of the infrastructure – drilling pads, access roads, pipelines, pumping stations, processing plants and other facilities – that must be installed to extract, process and transport the oil and gas. Direct impacts include the destruction of native vegetation, soils and wildlife habitat by the construction of this infrastructure. Potential indirect impacts cover a much larger area than this drilling "footprint" and include:

Increases in air pollution caused by emissions from vehicles, drill rigs, compressors and other engines, and dust caused by vehicular traffic;
The introduction of noxious weed species and invasive alien species;
Ground and surface water pollution caused by hydraulic fracturing operations and the disposal of drilling fluids and produced water;
Noise and light pollution;
Changes in the foraging behavior, breeding success, and migration patterns of wildlife; and
Aesthetic loss resulting from the industrialization of essentially wild or pastoral landscapes.
Much of this impact could be reduced by applying well-demonstrated technologies to shrink the direct surface footprint of oil and gas operations. Those of us who follow these issues have heard a lot about the potential benefits of one of these technologies – "directional" drilling, where multiple wells can be drilled to extend outwards from one location, maximizing the ability to recover oil and gas while minimizing the number of drilling locations that must be established on the land surface. Industry and government frequently mention directional drilling as a solution when environmental concerns are raised about new development. Unfortunately, this proven technology is not being routinely applied to minimize the environmental impacts of energy development on public lands in the Rocky Mountain West, especially with regards to the booming business of natural gas production. My experience as a consultant to industry throughout the 1990s, and my ongoing analyses of energy development projects using satellite and aerial imagery, confirms that the majority of drilling on public lands is still being done in the conventional, vertical manner. This old-fashioned solution requires many closely spaced drilling locations to efficiently extract natural gas from the low-permeability "tight gas" sandstone and coalbed methane reservoirs that are now

attracting so much attention from industry, resulting in maximum environmental impact.

The Jonah natural gas field in western Wyoming vividly illustrates this situation. Jonah is widely considered by industry as one of the most significant natural gas discoveries in North America of the past decade, and it has proven to be one of the most lucrative for its owners and operators. Its discovery resulted from a combination of new exploration and well completion technology. The Jonah field created a new paradigm for onshore natural gas exploration, and lead directly to a recapitalization of the Rocky Mountain energy business that has generated a modern-day boom in exploration and drilling, mostly on federally managed lands. Jonah clearly represents the “state of the art” in modern onshore natural gas production, and serves as a model to industry for finding and exploiting future gas plays in the Rockies. Indeed, one energy-industry representative recently testified to this subcommittee that his company expects to find “2 – 3 more Jonah-sized accumulations” within their leased acreage alone in the Jonah area.

New natural gas fields throughout the Rockies, including tight-gas sandstone plays in the Piceance and Great Divide basins and coalbed methane plays in the Uinta, San Juan and Powder River basins, mirror the development footprint that we see in Jonah on satellite and aerial images. Unless low-impact technologies are widely applied, we can expect to see much more development in the immediate future that looks like the Jonah field.

Jonah Natural Gas Field – Background Information
Location: The Jonah natural gas field covers 59,500 acres located 32 miles south of Pinedale in Sublette County, western Wyoming. To biologists, it lies within the southern part of the Greater Yellowstone Ecosystem, an important corridor for antelope and mule deer migration as well as critical winter foraging range. To geologists, the Jonah area is located in the northern part of what is known as the greater Green River Basin, a broad sedimentary accumulation that hosts significant oil, gas, and mineral resources. Most of the land within the Jonah field is publicly owned and is administered by the U.S. Department of the Interior’s Bureau of Land Management (BLM).

Geology: Jonah is a structurally controlled sweet spot within the continuous-type, basin-centered natural gas play of the Green River Basin. The reservoir is hosted by the Cretaceous-age Lance Formation, a low-permeability “tight gas” sandstone. Wells are drilled to a depth of about 8—10,000 feet and require special completion procedures that include fracture stimulation to effectively produce gas. The average pay-zone thickness is 500 feet.

Production: In 2000, the Jonah field yielded almost 200 million cubic feet (MMCF) of gas per day. By 2003, production had leaped to about 700 MMCF/day, with some individual wells initially producing up to 100 MMCF/day.

Reserves: At 3—5 trillion cubic feet (TCF), Jonah is the second-largest gas field in Wyoming and has earned the following praise from industry: “One of the largest gas discoveries in North America” and “Even by international standards, this is truly a significant gas play.” The adjacent Pinedale Anticline, now in the initial stages of full-field development, holds an estimated 6 TCF.

Well Economics: In 1998, the average well cost $1.5M to drill, complete, and bring online. In 2000 the average Estimated Ultimate Recovery (EUR) of gas was 6-7 billion cubic feet (BCF) per well. Ultra Petroleum Corp. reported in 2000 that new wells pay out in only 6-8 months and will produce for 30 years. Some Jonah operators are experiencing up to 100% rate of return on investment. Because these “tight sands” reservoirs in the Jonah and Pinedale Anticline area qualify as “non-conventional deposits,” natural gas extracted here would also qualify for Section 29 tax credits, which Congress is considering extending for several more years.

Jonah Natural Gas Field – Development Timeline
1975. Jonah Field is discovered by the Davis Oil – Wardell Federal #1 well. At only 303 thousand cubic feet (MCF) of gas and 2 barrels of oil per day the well is not economic, and there is little resulting activity. See Figure 2.

1992. McMurry Oil Company buys the field. There are only 3 existing wells in place. McMurry’s first production of gas is reported to the State of Wyoming Oil and Gas Commission in 9/92.

1993. Aided by new 3-d seismic survey and well completion/stimulation technologies, McMurry “rediscovers”

Jonah Field with the McMurry Oil – Jonah Federal #1-5 well, which produces 3.7 million cubic feet (MMCF) of gas and 40 barrels of oil per day.

1994. BLM issues "McMurry Oil Company Jonah Prospect Field Natural Gas Development Environmental Assessment" and limited drilling proceeds.

December 1997. 58 wells are in place (reported by BLM).

April 1998. BLM issues the Record of Decision for "Jonah Field II Natural Gas Development Project EIS" to allow full-field development:

Operators state that no more than 497 wells will be required for full extraction of natural gas from Jonah (300 – 350 is considered the "most probable" number)
One well is proposed at each drilling location, or "well pad"
The maximum allowed drilling density is one well location per 80 acres (8 pads per sq. mile)
BLM estimates there will be 2.5 acres of direct surface disturbance to construct each pad; the total surface disturbance is estimated to be 2927 acres, including the pads, connecting roads, pipelines, and other anticipated infrastructure
Full-field development of 497 wells will require 10 – 15 years (about 30 wells per year)
The total lifetime of the field will be 40 – 50 years.

December 1998. >90 wells are in place (reported by McMurry Oil Company).

December 1999. >150 wells are in place (reported in PTTC Newsletter). See Figure 3.

April 2000. 170 wells are in place (reported by BLM).

May 2000. BLM issues the Record of Decision for the adjacent Pinedale Anticline EIS:

The Pinedale EIS estimates that each well pad alone disturbs 3.7 acres (5 acres for multi-well pads), and access roads have a disturbance width of 40–52 feet
Analysis of aerial and satellite images shows that the development occurring in Jonah is consistent with these Pinedale EIS estimates.

June 2000. Alberta Energy Company buys out McMurry and becomes the major interest holder in Jonah; in 2002 they become EnCana Oil and Gas, the largest independent natural gas producer in N. America.

December 2000. BLM issues the Record of Decision that approves 40-acre spacing (16 pads per sq. mile) in the eastern half of the field ("Jonah Field Environmental Assessment, Sublette County, Wyoming"):

Operators repeat that 497 wells is adequate to extract the natural gas
In a Wall Street interview, Ultra Petroleum Corp. hails this decision as "clearing the path for dramatic growth in production, cash flow and earnings."

December 2000. >230 wells are in place (reported by BLM).

July 2001. 300 wells are in place (reported by BLM). See Figure 4.

March 2003. BLM reports that operators have requested permission for an infill drilling program that will add up to 1,250 new wells from up to 850 new pads ("Scoping Notice, Proposed Jonah Infill Drilling Project"):

Surface well spacing will decrease to 16-acre (40 pads per sq. mile)
BLM raises their estimate of surface disturbance for the original 497 wells and associated infrastructure by over 40%, from 2927 acres to 4225 acres
Infill drilling will:
Add 7225 acres to the surface impact, bringing the total to 11,450 acres (almost 4 times the original estimate given in 1998 EIS)
Nearly triple the number of well pads that were considered adequate by operators and BLM in 1998, and again as recently as December 2000 (from 497 to 1347)
Directly impact 20% of the total land area enclosed by the Jonah project.
The total field lifetime is reduced to 25 years, half of the original estimate.

May 2003. 435 wells are in place (reported by BLM). By late spring, BLM reports that over 500 wells are in place: more than allowed by the existing EIS, and installed in only five years rather than the 10 – 15 year estimate made in 1998. Satellite images graphically illustrate this explosive growth of infrastructure. See Figures 2 – 5.

August 2003. Media reports that a total of 3100 wells may ultimately be drilled in Jonah: 1300 in addition to the just-proposed infill program (Casper Star-Tribune).

Jonah Natural Gas Field – Development Illustration
The direct impact to the land surface of oil and gas infrastructure is clearly shown on pictures taken from earth-orbiting satellites. The examples here are from the Landsat series of satellites, which have been in continuous operation since 1972. Landsat is launched and operated by NASA. The images are distributed to government users and to the public by the U.S. Geological Survey. We purchased four Landsat images covering the Jonah field that were taken in 1986, 1999, 2000 and 2002. This time-series illustrates the extent of landscape impact and habitat fragmentation associated with the construction of well pads, access roads, and other gas field infrastructure. It also illustrates how rapidly these impacts multiply once federal land managers approve drilling.

In the following sequence of satellite images (Figures 2 – 5), the same 7-mile x 7-mile area covering the Jonah field is shown in 1986, 1999, 2000 and 2002. Disturbed land is very bright because the bare, dry soil reflects sunlight much more than undisturbed topsoil and vegetation. Well pads and access roads clearly appear as bright spots and lines against the darker undisturbed background. Each well pad is a graded area ranging in size from about 3 to 4 acres. Access roads are also graded, and range in width from about 40 to 60 feet. Figure 1 is a photograph taken from a low-flying airplane that shows a typical well pad, with the well actively being drilled.

Figure 1. Photograph taken in 2002 of a gas well being drilled on a typical well pad. Note pits containing drilling fluids, equipment trailers, and access road.

Jonah Field – 1986

Figure 2. Jonah field before discovery, as it appeared on a Landsat satellite image taken on August 27, 1986. Only two dirt roads are visible in the area, intersecting in the lower left. The area is mostly undisturbed high-desert sagebrush and grassland, characteristic of the Rocky Mountain intermontane basins. The topography is mostly flat-lying plains and mesas dissected by ephemeral streams.

Jonah Field – 1999

Figure 3. Landsat image of the same area, taken on October 26, 1999 after nearly 150 new gas wells and connecting roads had been installed with 80-acre spacing. Each bright rectangular region is a well pad as seen in Figure 1, representing the location of a single well. Dark spots on many of the pads are open pits containing drilling fluids and produced fluids that are separated from the gas.

Jonah Field – 2001

Figure 4. Landsat image taken on August 28, 2001. 40-acre spacing has been approved, and more than 300 gas wells have been drilled in the Jonah field at this point.

Jonah Field – 2002

Figure 5. Landsat image taken on October 18, 2002. By this time Jonah field now contains more than 400 gas wells and hundreds of miles of connecting roads. If the infill-drilling proposal is approved, up to 850 new well pads will be added to the field.

Conclusion
I hope this information adds a new perspective to your understanding of the environmental impacts of onshore energy production. Proven technologies exist that could help lessen the direct environmental impacts illustrated by the Jonah example, but for a variety of reasons these are not being applied. I urge

you to work together with industry, land-management agencies, and the environmental community to find mutually agreeable ways to better deploy these technologies, and to develop procedures for realistically evaluating the ultimate impact of development early in the scoping and approval process. For example, The Wilderness Society recently issued a report, entitled Fragmenting Our Lands: The Ecological Footprint from Oil and Gas Development, that contains a number of recommendations on how managers can better identify and plan for oil and gas activities in order to minimize their impacts on public lands.

Thank you for your time and attention today. I look forward to any questions you may have, and place myself at your disposal if I can be of further service.